

Utah State University

DigitalCommons@USU

UAES Circulars

Agricultural Experiment Station

3-1927

Circular No. 63 - Tomato Culture in Utah

A. L. Wilson

Follow this and additional works at: https://digitalcommons.usu.edu/uaes_circulars



Part of the [Agricultural Science Commons](#)

Recommended Citation

Wilson, A. L., "Circular No. 63 - Tomato Culture in Utah" (1927). *UAES Circulars*. Paper 49.

https://digitalcommons.usu.edu/uaes_circulars/49

This Full Issue is brought to you for free and open access by the Agricultural Experiment Station at DigitalCommons@USU. It has been accepted for inclusion in UAES Circulars by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.

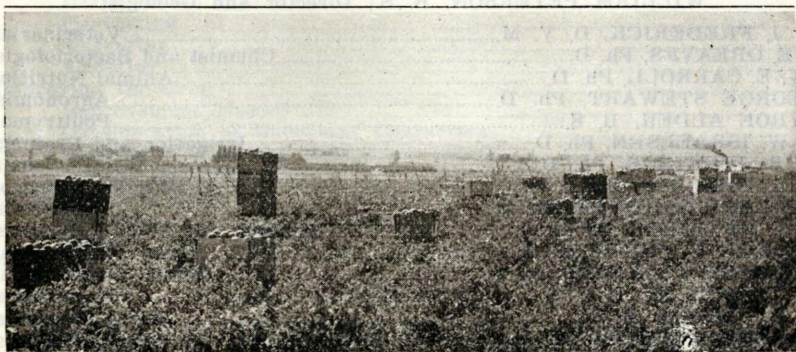


CIRCULAR 63

MARCH, 1927

TOMATO CULTURE IN UTAH

A. L. WILSON



UTAH AGRICULTURAL EXPERIMENT STATION

LOGAN, UTAH

UTAH AGRICULTURAL EXPERIMENT STATION

BOARD OF TRUSTEES

A. W. IVINS, President.....	Salt Lake City
C. G. ADNEY, Vice-President.....	Corinne
LORENZO N. STOHL.....	Salt Lake City
FRANK B. STEPHENS.....	Salt Lake City
ROY BULLEN.....	Salt Lake City
MRS. LEE CHARLES MILLER.....	Salt Lake City
MRS. BURTON W. MUSSER.....	Salt Lake City
J. R. BEUS.....	Hooper
JOHN E. GRIFFIN.....	Newton
WESTON VERNON, Sr.....	Logan
FREDERICK P. CHAMP.....	Logan
WILFORD DAY.....	Parowan
H. E. CROCKETT, Secretary of State (ex-officio).....	Salt Lake City
R. E. BERNTSON, Secretary.....	Logan

EXPERIMENT STATION STAFF

E. G. PETERSON, Ph. D., President of the College
 WILLIAM PETERSON, B. S., Director and Geologist

H. J. FREDERICK, D. V. M.....	Veterinarian
J. E. GREAVES, Ph. D.....	Chemist and Bacteriologist
*W. E. CARROLL, Ph. D.....	Animal Nutrition
GEORGE STEWART, Ph. D.....	Agronomist
BYRON ALDER, B. S.....	Poultryman
O. W. ISRAELSEN, Ph. D.....	Irrigation and Drainage
D. S. JENNINGS, Ph. D.....	Soils
R. L. HILL, Ph. D.....	Human Nutrition
WILLARD GARDNER, Ph. D.....	Physicist
B. L. RICHARDS, Ph. D.....	Botanist and Plant Pathologist
GEORGE B. CAINE, M. A.....	Dairy Husbandman
KENNETH C. IKELER, M. S.....	Animal Husbandman
H. J. PACK, Ph. D.....	Entomologist
P. V. CARDON, B. S.....	Farm Economist
CARRIE C. DOZIER, Ph. D.....	Home Economist
*R. J. BECRAFT, M. S.....	Range Management
C. T. HIRST, M. S.....	Associate Chemist
E. G. CARTER, Dr. P. H.....	Associate Bacteriologist
D. W. PITTMAN, M. S.....	Associate Agronomist
*M. D. THOMAS, A. B., M. S.....	Associate Soil Chemist
L. M. WINSOR, M. S.....	Associate in Irrigation and Drainage
A. F. BRACKEN, M. S., Assistant Agronomist and Supt, Nephi Substation	
T. H. ABELL, M. S.....	Assistant Horticulturist
A. L. WILSON, M. S.....	Supt, Davis County Experimental Farm
GEORGE D. CLYDE, M. S.....	Assistant in Irrigation and Drainage
CHARLES J. SORENSON, B. S.....	Assistant Entomologist
A. C. ESPLIN, B. S.....	Assistant Animal Husbandman
D. C. TINGEY, M. S.....	Assistant Agronomist
ALMEDA P. BROWN, M. S.....	Assistant in Home Economics
W. PRESTON THOMAS, B. S.....	Assistant in Marketing
GEORGE F. KNOWLTON, M. S.....	Assistant Entomologist
N. E. EDLEFSEN, M. A.....	Assistant Physicist
H. LORAN BLOOD, B. S.....	Assistant Plant Pathologist
WILLIAM H. WARNER, B. S.....	Assistant Poultryman
J. R. BATEMAN, B. S.....	Supt, Panguitch Livestock Farm
GEORGE Q. BATEMAN, B. S.....	Supt, Dairy Experimental Farm
JOHN W. CARLSON, B. S.....	Supt, Alfalfa-seed Experimental Farm, Uintah Basin
H. V. HALL, B. S.....	Supt, Sheep Experimental Farm
BLANCHE C. PITTMAN, B. A.....	Publications and Library
DAVID A. BURGOYNE, B. S.....	Secretary to Director

*On leave.

TOMATO CULTURE IN UTAH¹

By A. L. WILSON

TABLE OF CONTENTS

	Page
History of the Tomato.....	3
Importance of the Tomato.....	4
Growing the Plants.....	5
Hotbeds.....	6
Hotbed Materials and Construction.....	7
Hotbed Management.....	10
Equipment Necessary.....	14
Growing and Harvesting the Crop.....	14
Soil and Soil Management.....	14
Transplanting.....	18
Cultivation.....	21
Irrigation.....	22
Harvesting.....	23
Marketing.....	24
Varieties.....	25
Improving the Crop.....	28
Improvement Needed.....	28
Consideration of Important Characters.....	29
Methods of Selecting Seed.....	30
Testing the Selection.....	31
Controlling the Pests.....	32
Diseases.....	32
Insects.....	33
Summary.....	34

The object of this circular is to point out in a general way the essential considerations for successful tomato-growing in Utah. It has become necessary because of the increasing importance of this crop in the state as well as in the United States.

HISTORY OF THE TOMATO

The tomato is one of the few plants of purely American origin that has risen to a position of great importance as an agricultural crop. In this respect it compares favorably with such crops as corn, tobacco, potatoes, and sweet potatoes. From all available evidence it appears that the tomato originated in Central South America, probably in Peru. It was known and grown for use by the natives of Mexico, who called it Xitomate or Zitotomate, and by whom it was highly prized.

Apparently the tomato was not used by Europeans as food for upwards of a hundred years after the discovery of America. In many cases at first it was of more importance as an ornamental plant than as a food plant. The Italians were the first Europeans to discover its value for human food, and the first

¹Approved by Director, 10 March 1927.

attempts to grow it took place in Southern Europe along the Mediterranean Sea. Sometime later the English, French, and Germans began growing it, partly as an ornamental plant, and partly for food. The first mention of it in American records was in 1781, and it did not come into general use in the United States until well into the nineteenth century. Its rapid rise as an important vegetable crop did not take place until about 1870.

Because of its relationship to the deadly poisonous nightshade, people as a whole were afraid to eat it. This fear was not completely overcome until comparatively recent years. As soon as the "poison attitude" disappeared, the use of the tomato as a staple article of food increased rapidly, until now it is found in some form on practically every table in the United States and has been recognized by physicians and dieticians as a valuable source of materials very essential to good health and proper nutrition.

IMPORTANCE OF THE TOMATO

Tomatoes are exceeded in acreage and farm value only by potatoes and sweet potatoes among the truck crops of the United States. The average annual value for tomatoes during the period 1921-1925 was in excess of fifty-nine million dollars, while the value in 1925 reached sixty-one million dollars.

The wide range of climate within reach of American centers of population, together with the increasing efficiency in transportation, has made the market-tomato industry an important one. These factors, together with hothouse production, provide fresh tomatoes almost every day in the year, to those with means to purchase them. The growing of tomatoes for manufacturing purposes has kept pace first with the increased consumption of canned foods and secondly with improvement of canning methods. Hence, tomatoes in the manufactured form are available at all times of the year. They are not even dependent upon large yearly crops, since their adaptation to storage makes them available even in years of partial or total crop failures. The geographic distribution of canned-tomato products is dependent upon transportation facilities and the ability of the consumer to pay the price.

Utah's importance as a tomato-growing state has been dependent thus far almost entirely upon the canning industry. While the market gardeners have grown the crop for fresh tomatoes on a limited scale for several years, the enterprise never reached beyond local markets until about 1923, when the first carlot shipments of fresh tomatoes left the state. The

amount of these shipments has increased from year to year, until now there is a promising future for this type of tomato growing, and from all indications the canning and shipping phases of tomato-growing will develop side by side in the future.

The canning industry in Utah started at Ogden in 1888 with one small plant. The output was about 4000 cases of tomatoes, which were grown on about 35 acres of land in the vicinity of Ogden. The original company is still in existence and has grown to be one of the largest canning concerns in the state. From this humble beginning the industry has grown until, in 1925, there were 25 companies operating 41 factories, with a total capitalization of \$40,000,000. In 1925 these companies used in various manufacturing processes 126,000 tons of tomatoes from over 7100 acres of land. More than this, they enjoy an enviable national reputation for quality.

While the shipment of fresh tomatoes as "green wraps" is still in its infancy, there seems to be little doubt, that as suitable varieties are discovered and as cultural and packing methods are improved, this industry will increase and eventually constitute a profitable enterprise in Utah, without detracting in the least from the important position already established in the production of canning tomatoes.

GROWING THE PLANTS

The numerical importance of tomato plants in Utah is obvious from the fact that Utah farmers plant from 3000 to 5000 acres of tomatoes every year and have grown as many as 8000 acres. It requires 2,800,000 plants per one thousand acres for the first planting and an additional 1,200,000 for replanting, or a total of 20,000,000 plants for 5000 acres. In the past there have been two sources of supply for the required plants: (1) The grower raised his own plants or (2) the canning companies furnished them at a nominal price. If the canning companies provided them, they either hired local farmers to grow them or they imported them from California or elsewhere. The use of imported plants has increased tremendously within the last five years.

Frequently tomato growers have undertaken to grow their own plants and for various reasons have failed and have been forced to fall back upon the canneries to supply them, often at an inconvenience to both parties. Some of the causes of these failures are analyzed in the following paragraphs. Before this is undertaken, however, something should be said concerning the practice of importing tomato plants.

The value of Georgia plants or California plants is far from proven. The opinions of growers are about equally divided for and against imported plants as compared to home-grown plants, all of which emphasizes the fact that home-grown plants vary greatly in quality. This is equally true of imported ones. Aside from the relative merits of the plants themselves, there is a positive danger in sending away for seedling plants. This danger was emphasized a few years ago, when Colorado potato beetles were discovered on a shipment of Eastern plants. While some folks were inclined to ridicule the "finicky" inspectors who made so much ado over a dozen or so bugs, it is most fortunate for the Utah tomato industry, as well as for potato-growing, that these bugs happened to be so few, or in a very few years the grower would be concerned about much more serious matters than hotbeds. Moreover, potato bugs are not the only pests that may be brought in by imported plants. There is already an alarming amount of wilt, and there are yet other pests, unknown to Utah, that might be imported along with tomato plants. No serious consequences have occurred to date, but there is no guarantee for the future since this practice is a potential source of both insect and fungous pests. In view of this condition, the really sensible thing to do is to use only home-grown plants.

HOTBEDS

Function.—The function of a hotbed is to extend the normal growing season so that crops may be grown which require more time than the average season affords. Thus, the average time for a Stone tomato to ripen only a major portion of its fruit after the seed is planted is about seven months, or from early March to early October. The season adapted to field culture begins May 1 to 10 and generally ends about October 1. This is only five months. Hotbeds provide for the additional two months. Hotbed management involves several processes, among which are the generation of heat and the conservation of heat. In most cases manure functions in the first process, while the hotbed frame together with its coverings performs the second function. Both are essential.

Types.—There are two general types of hotbeds—those in pits and those above ground. The end profile of each of these types is indicated in the accompanying sketches. Each kind has its merits and its demerits. Surface types are slightly more convenient than pit hotbeds and are the only type that can be used where the ground is poorly drained. On the other hand, this kind is harder to protect from winds and requires more

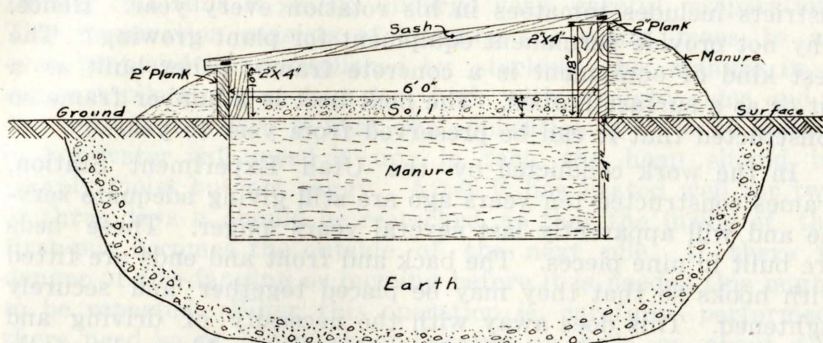


FIGURE 1. Pit type hotbed

manure. The pit system gives much the better protection and requires the least amount of manure. Where drainage conditions will permit this type is preferable.

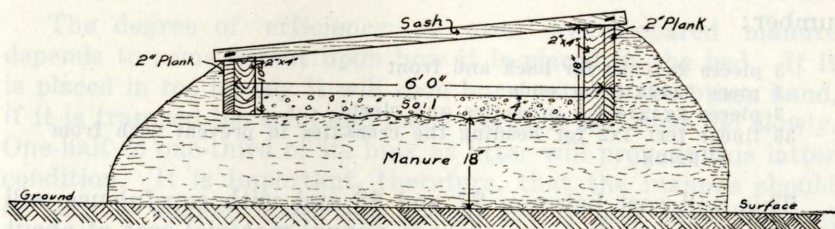


FIGURE 2. Surface type hotbed

Failures.—As previously stated, many growers begin with good intentions and end with imported plants. In most cases, failures have been due to faulty construction or improper management.

HOTBED MATERIALS AND CONSTRUCTION

Materials.—Whichever system is used, a frame is necessary to enclose the soil and to keep in the heat. Defective materials used to make the frame constitute a common cause of failure. Too often the hotbed frame is thrown together from materials that happen to be at hand. Frequently such lumber is either warped, split, spliced, or full of nails or bolt holes. With such lumber it is impossible to fit ends and corners tightly together. Someone will surely say that plants need ventilation anyway. It is true that plants need ventilation, but there are ways to accomplish this under absolute control, a condition that is not possible with hastily constructed frames from lumber often good only for firewood. The really successful farmer in tomato

districts includes tomatoes in his rotation every year. Hence, why not provide permanent equipment for plant growing? The best kind of equipment is a concrete frame, either built as a pit or as a surface hotbed. The next best is a lumber frame so constructed that it can be preserved from year to year.

In the work conducted by the Utah Experiment Station, frames constructed ten years ago are still giving adequate service and will apparently last several years longer. These beds are built in nine pieces. The back and front and ends are fitted with hooks so that they may be placed together and securely tightened. This does away with the necessity of driving and pulling nails every year. It also makes it possible to dismantle the bed in a few minutes, so that it may be laid away in such a manner as to prevent warping and weather-cracking. The cross-ties are notched into the back and front. Thus, they are simply laid in when the bed is set up and lifted out when the bed is dismantled. An 18-foot bed will require the following lumber:

- 3 pieces 2x10x20 for back and front
- 1 piece 2x10x18 for ends
- 3 pieces 2x4x14 for cross-ties and cleats
- 35 linear feet 1x2 for beading the cross-ties to prevent sash from slipping.

This will cost between \$7 and \$8 and with careful use will last ten years, making an average annual material cost of about \$1.25, including interest, for an 18-foot bed. At this rate no tomato grower can afford to be without adequate hotbed frames.

Location.—The location of a hotbed is important. The total labor required for a successful bed is not very great. However, frequent attention for only a few minutes at a time is positively necessary. Hence, the best place to install a hotbed would be along a path that is frequently traveled. Near the barn, or along the path between the house and the stables would be ideal, other things being equal. The value of such a location will be materially increased if it is protected on the north side by buildings, trees, or other types of windbreaks.

Preparation of Manure.—Hotbed heat is generally obtained from the fermentation of animal manure. Horse manure gives best results. Cow manure heats too slowly, while poultry and hog manures heat too rapidly. Even clear horse manure heats too rapidly and requires from one-third to one-half of its bulk as straw. It is better to mix the straw as litter in the stable, but it may be mixed in the pile. Manure for hotbeds should be obtained at least ten days, or two weeks, before it is needed.

During this time it should undergo very careful preparation. This preparation consists of bringing the entire mass to an even heat and is accomplished by stacking the manure in a compact pile three or four feet high with straight sides and a flat top. If it is slow to heat, the application of 10 or 15 gallons of hot water will speed it up; in fact, the heap should be thoroly moist but not soggy. After it has heated well for two or three days it should be restacked, so that the inside of the first pile becomes the outside of the next pile. If there is danger of fire-fanging or burning before it is needed this ought to be repeated. When this operation is carefully performed, there need be no worry about burning up beds, or about the production of ammonia. When the second or third pile is well warmed thruout it is ready for use. If the manure contains excessive amounts of straw it may be necessary to pack rather firmly either by light tramping or beating with the back of the fork.

The degree of efficiency of even well-prepared manure depends to some extent upon how it is placed in the bed. If it is placed in too loosely it will soon burn out; on the other hand, if it is tramped too solid and made soggy it will heat too slowly. One-half to one-third of its bulk as litter will prevent this latter condition. It is important, therefore, that the manure should be thoroly shaken apart and spread evenly and then tramped to make a moderately firm pile. Fifteen to twenty inches of properly prepared manure should furnish sufficient heat under ordinary circumstances. When the manure has been placed the frame may be installed and the soil added.

Soil.—For some reason or other the idea prevails among many tomato growers that the most infertile, sandiest soil that is obtainable is the right kind for hotbeds. This practice constitutes one of the most serious mistakes in hotbed management. Moreover, occasional success with this type of soil does not carry as strong an argument in favor of its use as the great number of failures do against its use. It is true that clay soils are not very good for hotbeds, but fertile soils are a necessity for the right type of growth. The best kind of hotbed soil is rarely found in nature. In fact, it is a blend and in most cases has to be mixed by the grower. A good soil combination is made by mixing two-thirds fertile loam and one-third well-rotted sifted manure. If this has a tendency to pack too hard, a few shovelfuls of sharp sand should be added and the whole mass thoroly mixed. This combination provides ample fertility, a good root base, and adequate tilth. With suitable ventilation

and watering it is capable of producing plants superior to imported ones. The depth of the soil will vary to some extent. Ordinarily five inches is considered about ideal for most purposes.

Because diseases may be accumulated in hotbeds the soil should be changed every year. This is particularly necessary to prevent so-called "damping-off" in the bed itself and to prevent the contamination of fields with such diseases as *Fusarium* wilt.

Better results may be obtained if the soil is placed in the bed a few days before seeding time. This gives it an opportunity to warm up, and germination is accordingly hastened. It also gives weed seeds a chance to germinate which can be destroyed before tomato seeds are planted. If the soil has been worked over sufficiently to mix the ingredients recommended above, it will be pretty well pulverized and in good condition to receive the seed. Of course, it is necessary that it contain the right amount of moisture.

HOTBED MANAGEMENT

Seeding.—After the soil is warmed thru, the seeds are planted. They may either be sown broadcast or planted in rows. The latter method makes future management more convenient. A quick, easy method is to make furrows about two and one-half to three inches apart and about one-fourth to one-half inch deep with the edge of a lath. The seeds are planted in these furrows and are covered by splitting the ridges between the rows, and leveling afterwards by means of a piece of thin straight lumber. A lath or piece of box lumber does well. If the surface is watered lightly and covered with burlap, germination may be further hastened. However, the burlap must be removed before the seedlings come in contact with it, or they will either curl under or grow into the burlap and be pulled up when it is removed. The rate of seeding depends upon whether the plants are to be hardened in the hotbed or whether they are to be transferred to a coldframe. In the first case there should be no more than 75 plants matured in a 6-foot row. In order to secure this number of sturdy plants, probably twice as many seeds should be planted, or about two seeds per inch, and the plants thinned out to 75 or about one plant to the inch. Overcrowding is disastrous for several reasons: (1) The plants grow long and spindling; (2) they can never be hardened effectively; and (3) they are much more susceptible to disease. The writer has had his attention called to several failures due to overcrowding. On one occasion a bed of rather fine plants, if looked

at from above, was presumably ready for the field. When the grower pulled them he found that nearly every plant was ringed with a band of dead tissue. Disease had attacked them without his discovering it. Moreover, the plants were long, rather thin-stemmed, and soft. When a count was made it was found that there were as many as sixteen plants per inch of row. Obviously, one real plant was of more value than the entire sixteen. One plant per inch of row is all that should be allowed to grow. If the plants are to be hardened in a coldframe, 200 or even more may be grown with safety in the same length of row. Of course, even this may be too many if seedlings are not transplanted until second or third leaves are formed.

When plants are to be hardened in the bed, seeding should be done about six weeks previous to setting in the field. With proper care, beds planted March 15 to 20 will be ready for the field May 1 to 10. However, if coldframes are to be used, seeding should be done a week or two earlier.

Protection.—Too much dependence has been placed in muslin covers. Of course, the user of muslin need not worry very much about ventilation, and when severe cold comes or heavy snow falls, there is not much use of worrying. In contrast to this, the experienced man, with ventilation under control and with covers adequate to retain a maximum amount of heat and rigid enough to withstand the weight of several inches of snow, is prepared for any emergency. Glazed sash makes the best type of covers for hotbeds. In addition to glass, a 10-ounce duck cover of convenient size is desirable for ideal hotbed equipment. This may be equipped with eyelets for attachment to the permanent frames. In some sections of the country, straw mats are used for this purpose. Where glass cannot be afforded, the duck cover is much more efficient than muslin. However, preparation should be made for additional covering in case of storm or cold weather. Old quilts, or wagon covers or even straw are sometimes used.

Ventilation.—While the production of good plants is within the possibility of every grower, there are certain requirements that must be satisfied with exactness. As stated, the total amount of time required is not great, yet this labor must be done at the right time. Improper ventilation is the cause of a great many failures.

It needs to be constantly borne in mind (1) that every living thing must have access to fresh air and (2) that every form of life gives off gases, which, if allowed to accumulate, eventually cause death. The function of ventilation is to regulate these

two vital conditions and in addition to regulate the moisture content in the air. Briefly, the hotbed should be ventilated practically every day. Occasionally, there are days when it would not be wise to open the bed at all, but they are relatively few. The very best hotbeds can easily be ruined by keeping them covered for several days in succession. With the exception of severely cold days, the sashes should be opened a short time during the middle of every day. This may be accomplished by raising the sash from one to six inches. Care must be taken to guard against draughts. To avoid them, raise the sash on the opposite side from the direction of the wind; thus, if the wind is blowing from the west, raise the east side of the sash. The collection of the least amount of moisture on the glass indicates that the bed needs ventilation. As the days become warmer, the amount of ventilation should be increased, and as the time for transplanting approaches the bed should be left uncovered day and night.

Irrigation.—Improper irrigation also causes many failures. This feature is very important and should receive careful attention. It is very easy to under-water and a little easier to over-water. Over-irrigation and poor ventilation ruin many fine beds of tomato plants. Perhaps the most serious mistake in watering is to apply light daily sprinklings. Such a practice keeps the surface of the bed moist, which provides an ideal condition for disease, but the water never reaches the roots. In addition, the roots that develop will be small and near the surface. The safest plan is to water cautiously but thoroly. Examine the soil deeply rather than just the surface. The time-worn custom of squeezing the soil in the hand is far safer than judging the surface wetness. This of course applies after the seeds have germinated. It is best to irrigate in the forenoon on bright days, since this gives ample time for surplus moisture to escape while the bed is being ventilated. However, there should be no hesitancy about watering hotbeds when there is real need for it, irrespective of the time of day.

Plants should not be pruned or cut back. If at any time it becomes necessary to check their growth, this should be done by withholding moisture and lowering the temperature. This process will cause the plant to set out branches in the axils of the leaves.

Hardening.—Considerable has been said already about hardening. The function of this process is to prepare the plants to withstand the shock of being moved from the artificial conditions of the hotbed to the more vigorous environment of the

field. It consists of two general processes: (1) the enlargement of the root system and (2) a toughening of all the tissues. Lowering the temperature and moisture to approximately field conditions tends to toughen the plants, while the root system is increased by transplanting to coldframes or by what is known as "sanding-up", which consists of sifting soil about the plants. While there is no particular objection to sanding-up, transplanting to a coldframe is a surer and safer method of obtaining thoroly hardened plants with a large root system. It has the disadvantage of being slightly more expensive than sanding-up. The bed will also need to be planted two weeks earlier. It consists of transplanting the plants into coldframes when the first true leaves are formed. For the best results they should be set into the ground up to the seed leaves. If the plants remain in the hotbed until the second or third pairs of true leaves are formed it may be necessary to set deeper. The best plants are obtained by setting out in the coldframe 4 by 4 inches apart. This would be too expensive for the canning crop. Very good plants may be produced at 2 by 1½ inches apart, which is adequate for the canning crop. The coldframe is made in the same manner as the hotbed except that the manure is omitted.

The best type of plant is one that is about six to eight inches long and about three-sixteenths to one-fourth inch thick just above the root. It should have an abundant root system and be thoroly hardened.

Hotbed Diseases.—The principal seedbed disease is known as damping-off and may be caused by one or more fungi. The methods of control which have already been mentioned may be summarized as follows:

- (1) Over-crowding should be avoided.
- (2) Irrigation must be regulated so that the soil surface is not continuously wet.
- (3) Excessive moisture in the air should be avoided by properly ventilating the bed.
- (4) In case damping-off starts in the bed, the surface of the soil should be immediately dried and the sunshine allowed to enter the bed. A thin layer of dry sand will usually check damping-off.
- (5) New soil should be provided each year.

In view of the rapidly spreading *Fusarium* wilt, all hotbed equipment should be thoroly sprayed or washed annually with formaldehyde (1 pint to 30 gallons of water). If thoroly done,

this treatment will kill any spores that might remain over from the previous year.

Mosaic is another disease that may obtain a foothold in the hotbed and be disseminated by the transplanting operations.

EQUIPMENT NECESSARY

A good practice would be to grow seedlings in a hotbed and transplant to coldframes. If transplanted at the right time, a 6-by-18-foot hotbed will produce 20,000 seedlings, or sufficient for about 5 acres. Five coldframes in addition would be necessary to care for these. The hotbed may be raked over and used as a coldframe, thus necessitating only four other frames. This would require seeding about March 1 and would take the following equipment per 20,000 plants:

5 sets (18-ft. hotbed or coldframe).....	\$40.00
5 10-ounce duck covers, 7x20 feet.....	37.50
6 hotbed sashes with glass.....	30.00
Ordinary garden tools usually found on every farm	
Total cost.....	<hr/> \$107.50

With good care this entire equipment will last ten years, making a material annual cost of \$10.75, exclusive of interest. Under present methods, muslin or factory cloth is seldom used more than one year. Each bed would require about 14 yards, which will cost in the neighborhood of 20 cents a yard, or a cost per bed of \$2.80. It will take at least four beds for 20,000 plants which will make an annual muslin cost of \$11.20. When this cost is considered, together with the fact that new lumber must be bought frequently for temporary beds, it appears that the greater initial investment for permanence is fully justified, even if the increased quality of plants is overlooked.

GROWING AND HARVESTING THE CROP

SOIL AND SOIL MANAGEMENT

Kind of Soil.—The tomato will grow and do well on most kinds of soils. In its native state it is a perennial plant and, therefore, will continue to grow as long as conditions permit. The maturity of the crop depends in great measure upon fertility and the capacity of the soil to hold moisture, and these in turn depend in some degree upon soil type. For example, as a general rule sandy soils on the one hand are most likely to be deficient in fertility and especially in their capacity to hold moisture, while on the other hand clay soils are usually very

fertile and have greater moisture retentiveness. Between these extremes may be found any variety of intermediate stages. Sandy soils yield more readily to cultivation than clay soils and can be kept in better tilth. But, while the tomato is adapted to many soil types, it reacts in a different manner to each one. Thus, sandy soils which hasten maturity are light producers, while the heavier soils tend to delay maturity but yield larger crops. For this reason the market gardener who is interested in the high price of early tomatoes does well to choose a sandy soil even tho the crop is not large, while the grower for the cannery must choose a heavier soil since his returns depend upon a larger volume at a smaller price. The length of the average growing season, that is, the time between the last killing frost in the spring and the first killing frost in the fall, should be taken into account in selecting a soil for growing canning tomatoes. If, as is the case in the main tomato-growing section of this state, the average fall frost date occurs during the last few days in September, the obvious thing to do is to select a soil, which under the best cultural practice can be depended upon to mature most of the crop of a desirable variety by that date. It is really pathetic to see a fine crop of tomatoes ruined by a mid-season freeze just because the grower chose too heavy a soil. However, when the first fall frost comes two or three weeks later than the average autumn frost date, the grower on the heavier soil reaps a bounteous harvest. But gambling on a long season is a big risk and as a general practice is unprofitable.

Under average conditions the sandy loams are the best soils for the growing of tomatoes for the cannery. Tomatoes for green shipment probably ought to be grown on a slightly heavier soil than those for canning, since it is desirable to have the bulk of the crop come on toward the latter part of the season, as the demand is greater at that time than it is in August and in early September. It is very disastrous to plant tomatoes on poorly drained ground. In the first place, if the soil moisture is excessive the plants will not thrive. In the second place, if the moisture is just beyond the amount necessary for setting the heaviest crop, the plant will "grow to vine", instead of setting fruit, especially if it is planted on fertile soil. But the tomato requires a soil capable of holding an optimum amount of moisture for its best growth, and sandy soils are more or less deficient in this respect. So if the sandy loam soil, which is easily handled and which matures the bulk of the crop in due season, is underlaid at a suitable depth with

a well-drained clay subsoil, which prevents moisture from seeping away too rapidly, an ideal soil condition exists for profitable tomato-growing when other factors are favorable.

Soil Fertility.—The question of fertilizers and their place in the crop rotation is an important consideration. Unfortunately, very little information of an authentic nature is available in Utah. Much work has been done on these problems in sections which depend upon rainfall for moisture, and which of course have only general application under Utah conditions. Moreover, fertilizer requirements have been found to differ widely for different soils and to be dependent not only upon soil type, but upon its previous management and crop history. Also productivity is not only dependent upon there being adequate amounts of water and the essential plant-food elements nitrogen, phosphorus, and potassium in the soil but also upon there being proper balance between them. Investigators who have studied the fertilizer requirements of tomatoes are rather generally agreed that phosphorus is most likely to be the limiting plant-food factor, and in case of sandy soils there may also be a deficiency in nitrates and potash. In many parts of the country barnyard manures are no longer available in sufficient quantities, and growers have been forced to use commercial fertilizers. However, as long as the Utah grower has access to barnyard manures he need not worry about chemical fertilizers. The tomato plant does not make a very heavy drain on soil fertility. Nearly half of the minerals taken up by the plant are returned to the soil when the plant residues are plowed under.

The fertility of the greater part of Utah tomato soils may be maintained at a point for tomato-growing by careful attention to rotations. Because the tomato does not make an exhaustive drain on fertility, it does very well after a crop that does impoverish the soil more or less. Hence, it ought not to occupy the most fertile place in the rotation on the heavier loams. In this connection it might also be better to apply the manure to the heavier feeding crop. However, in the case of the light sandy soils, where the tomato is the principal cash crop and probably the only one, it should be given the best place in the rotation.

The matter of fertility is only one of the many factors involved in the question of rotation, and probably not the most important one in Utah. For a long time the tomato grower in this state has enjoyed relative freedom from soil-borne diseases, but with the entrance of *Fusarium* wilt and its rather rapid spread, a new problem confronts the grower. Without discuss-

ing this problem at any length, it might be stated that it is really unsafe to plant tomatoes on the same piece of land oftener than once in five years because of the presence of this disease in tomato soils. The importance of this practice may not be appreciated at this time, but sooner or later it will become imperative to the success of the industry.

Preparation of the Soil.—Success depends upon thoroly preparing the soil to receive the seedling plants. Plowing should be deep (8 to 10 inches) and carefully done. There might be some soils, which for special reasons, give best results when spring-plowed, but in most cases fall-plowing is preferable. This is especially true if they contain appreciable amounts of either silt or clay. When such soils are spring-plowed, it is frequently a difficult task to reduce them to the fineness required by most plants. Tomato seedlings, like most crops, fail to start well in cloddy soil. Both moisture and an abundance of soil heat are necessary for tomato plants to start growth after transplanting. Cloddy soils lose moisture too rapidly and require more frequent irrigation. Irrigation always lowers the temperature of the soil, and as a consequence checks the growth of the plant if applied at a season when soil temperature is likely to be at a minimum. For this reason, a fine, firm plant bed is necessary in order to conserve moisture and to absorb all the heat possible from the sun's rays. The importance of an early start under the most favorable circumstances cannot be over-emphasized. The growing season is all too short at best. To lose growth at the beginning is to lose crop at the end, and the grower is fortunate if he is not compelled to take a total crop loss by an early frost. A crop which must struggle for two or three weeks before commencing to grow has not the same chance to produce either the quality or the quantity of fruit that a crop has which starts to grow almost as soon as set out. Hence, a little extra labor, in harrowing and leveling and in otherwise fitting the soil, will pay for itself several times in increased earliness and yield.

Just before transplanting, the field must be marked off to insure proper spacing and uniformity of planting. Various devices are used for this process, but the most effective is a 4-row sugar-beet cultivator, equipped with irrigation shovels set at the proper distances apart. With this equipment a careful driver can draw furrows accurately and straight. A field with straight, uniformly spaced furrows is a compliment and a pride to the grower. If the field is check-rowed, that is, marked in both directions, it reduces the amount of hand work needed and

increases the efficiency of cultivation. Whenever convenient, this method is preferable.

TRANSPLANTING

The process of transplanting consists of all of the operations necessary to remove the seedlings from the hotbed or cold-frame and to establish them in the field. Care should be taken to accomplish this with as little injury to the plant as possible.

Time of Transplanting.—The seedlings should be set into the field just as soon as danger from freezing will permit. As a rule, the period of the last killing frost is known within a few days. Wherever temperature records covering a period of years are available, the average date of the last killing frost in the spring can be determined. The U. S. Weather Bureau has made these determinations for a number of places in the state, which they call the mean average frost date.* Of course, there will be variations from these averages in specific years and for places at some distance from the Weather Bureau stations. But the safe practice is to be ready to plant about the time of the average frost date, bearing in mind that a week or ten days' extra growing season in the spring may mean the difference between profit and loss at the harvest season. Generally, it is worth the gamble to plant a week earlier and to be prepared to replant in case of frost. The experience of most careful growers has been that the extra yield in the years they win is worth many times more than the cost of the extra plants on the years they lose the first planting by frost. In nearly every section where tomatoes are grown at the present time, it is safe to plant during the first week or ten days in May. The longer planting is delayed in the spring, the later the harvest will be in the fall. In some years the market gardener might plant as early as the middle of April. Of course, he must be prepared to protect his plants in the field by use of various plant-protecting devices, and in addition ought to be prepared to replant a second or third time if necessary. This means considerable expense for plants. It is not unusual for early tomatoes to sell for five dollars or more per lug, so that a little extra risk to secure earliness is justifiable. The point is that every available device should be used and every favorable practice followed that will contribute toward getting the larger price, and a few dollars spent for a second planting is insignificant compared with the extra returns, if the first planting succeeds.

Distance of Planting.—The distance of spacing the plants varies from 3 to 4½ feet, depending upon the type and fertility

*See Table 2, page 26.

of the soil. On a light, infertile, sandy soil, three by three feet, or three by four feet apart, may not be too close. On the other hand, in the case of highly fertile, fine sandy, or silt loams, it would frequently be better to space plants four by five feet apart, or even five by five feet apart. However, four by four feet apart is the best distance for planting under average conditions in this state. The only exception of note is in case of the more infertile, sandy soils where the distance may be reduced with profit to three by three feet. The distance apart is also dependent upon the variety. Earliana may be planted much closer than the ranker-growing Stone.

Methods of Transplanting.—One practice frequently followed in transplanting is to plant the seedlings along the side of a furrow that has been previously watered by pushing them into the soft mud with the hand. It will be difficult to plant this way if the ground is compact, or if it contains gravel, or if the plants are very tall. It then may become necessary for one man to open the ground with a shovel, while a second man places the plant at the proper depth and firms the soil about it with his feet. If this method is used, it would be better to have the water follow immediately after the planters, in order to moisten the roots well and to pack the soil tightly about the fine rootlets. Frequently, plants are set out during a storm, when irrigation is unnecessary. In addition, cloudy weather gives the plant a chance to establish itself without loss of much moisture from the leaves. At present, there are a number of patent planters on the market from a hand-planter to a 2-horse-drawn planter, which sets two rows at a time. Most, or all, types consist of devices which open the ground while operators place the plants, and then another mechanical device trips a cup of water into the hole about the plant. In the hand apparatus, the operator closes the hole with his feet, but in the horse-drawn planters the hole is closed by a shoe which presses the soil about the plant. Mechanical planters have not been used very widely in Utah as yet, but in some recent trials they have given general satisfaction. It is a little more difficult to plant in straight rows in both directions with machinery than by hand. However, it is claimed for one make of planter at least that if the ground is cross-marked in advance and if the operators are careful, this can be accomplished with a fair degree of accuracy.

Successful transplanting depends very largely upon the method of handling plants. A few homely "don'ts" may effectively impress this fact.

“Don’t” pull the plant out of the hotbed or coldframe without first loosening the soil with a spade or a trowel. Considerable work and expense has been incurred in producing plants with good root-systems. It is a mistake to injure these roots by carelessly pulling plants up. In order to harden plants, the soil in the bed has been allowed to get dry. This probably means that it is also hard. To overcome this condition, thoroly soak the ground far enough in advance so that mud will not hang to the plants but so that the soil will be moist and loose enough to get the major portion of the root out without serious injury.

“Don’t” dig up too many plants at a time. If the bed is close to the field, plants should be dug only fast enough to keep the planters busy. But if the bed is at some distance from the field it may be necessary to dig a half day’s supply, or even a day’s supply at a time. In such a case, they should be packed in such a manner as to keep the roots moist and the entire plant shaded from the sun. Transplanting is a severe shock to the plant under the most careful handling, and every precaution should be taken to prevent drying of roots, and wilting of the stem and leaves.

“Don’t” allow planters to carry a handful of plants with the roots exposed to the sun. Some exposure cannot be avoided, but too frequently more plants are taken in hand than can be planted before the roots dry. It is a good practice to carry plants in a bucket, or some other receptacle which protects them, and to draw out only one plant at a time. One horticulturist in another state advises dipping the roots of plants in thin mud, made of clay and water, which hardens and forms a case over the roots and prevents water loss. It is also a bad practice to have plants distributed very far ahead of the planters. Of course, planting time is a busy time, but precaution always pays.

“Don’t” fail to properly fill the soil in about the plant. If the hole is left open, air circulates freely thru it and both the plant and the soil lose moisture. A similar mistake is made by pressing the soil about the top of the plant and leaving a pocket about the roots. The plant is dependent upon the roots for water, and the roots cannot obtain it unless the moist soil is in contact with them. This is one of the valuable reasons for irrigating after rather than before planting, because as the water enters these pockets it carries soil particles and packs them about the roots.

“Don’t” be afraid to set long plants deep. Unless the plant be pot-grown, and branched considerably, 4 to 6 inches is all that

is necessary above ground. Any surplus length may be valuable below ground, since roots will develop along the entire underground portion; if left above ground, it gives the wind greater opportunity to damage or break the plant by whipping it about.

"Don't" irrigate too often after planting; give the soil a chance to warm up. The seedling needs warmth as much as water. If it is standing still it may be because the ground is too cold. Be sure there is need for water before it is applied.

CULTIVATION

Importance.—Cultivation is a big factor in successful tomato-growing. It is of major importance since it influences the vigor of the plant, the earliness of ripening, and the total yield.

Experiments were conducted in Indiana some years ago, covering a period of three years, to determine whether more thoro cultivation than was being given by the average grower in that state would be profitable. The tests consisted of two plats, the one cultivated as nearly as possible like that cultivated by the average grower, while the other was cultivated several times in addition to the regular number. The results were as follows:

TABLE NO. 1—Value of thoro cultivation*

	No. of Cultivations			Tons Yield per Acre			Value of crop per acre after paying for cultivation		
	1st Yr.	2d Yr.	3d Yr.	1st Yr.	2d Yr.	3d Yr.	1st Yr.	2d Yr.	3d Yr.
Average Cultivation	4	3	3	2.52	9.75	9.49	\$23.20	\$ 94.59	\$ 93.40
Thoro Cultivation....	15	9	8	4.63	13.78	13.36	26.80	130.30	128.10
Net profit in favor of thoro cultivation.....							3.60	35.71	34.70

*Adapted from Ind. Agr. Exp. Sta. Bul. No. 165 (1913) pp. 821-822.

While the net profit was low the first year, due apparently to a generally poor crop, the second and third years the extra cultivations paid good dividends.

The function of cultivation is at least three-fold: (1) to control weeds, (2) to insure the proper air content in the soil, and (3) to conserve soil moisture. It should commence just as soon as the ground dries sufficiently after transplanting and continue as long as the size of the plants will permit. The very early cultivations are especially important. Mention has already been made of the value of early cultivation in helping to warm up the soil. In addition, it loosens the soil and increases

the air content, giving the soil bacteria a chance to aid fertility, all of which are necessary for the young plants to establish themselves to the best advantage.

Depth of Cultivation.—These first cultivations should be deep and close up to the plant. In a check-rowed field there should not be more than three or four inches at most on each side of the plant to be hoed. As the plants begin to grow rapidly, the root system also extends rapidly and soon penetrates thruout the soil in search of food. The major portion of this food is found within the first few inches of top-soil. For this reason, all cultivations after the first two, or probably three, should be farther from the plants and above all else, very shallow; otherwise, the feeding-roots will be destroyed and the plant checked in proportion to the destruction. It is a good practice to examine the cultivator blades and the shanks occasionally to see if roots are being torn up. If the shank holds a mass of white string-like roots, it is a sure indication that cultivation is too deep and a warning that all future cultivation should be just deep enough to destroy weeds and to keep not more than two inches of the top soil mulched. It will be necessary to cultivate after each irrigation, but as the plant grows the furrows may be moved farther and farther away until they are half way between the rows.

IRRIGATION

Time of Irrigation.—Usually, the land is irrigated either before or immediately after the plants are set in the field. This is to insure an ample supply of moisture for the plant, while it adjusts itself to the new conditions. It also aids in settling soil about the roots of the plant. Beyond these two needs, it has no other important function under normal conditions, since the soil is almost always supplied with sufficient moisture for an established plant at this time of the year. On the other hand, excessive irrigation following transplanting may do considerable damage in lowering soil temperature at a time when the plant is more likely to be in need of warmth in the soil than in need of additional moisture. Unless the season is unusually dry, further irrigation may be delayed for two or three weeks after transplanting, provided the field is properly cultivated. The experienced grower can readily tell by the color and vigor of the plant whether or not it is in need of water. Examination of the moisture content in the soil is always helpful, but the plant is the best indicator of its water needs.

During the growing season, water should be applied often enough and in sufficient amounts to keep the plant thrifty and in continuous growth.

Amount of Irrigation.—There is a definite relationship of the vegetative vigor of the plant to its fruitfulness. Most growers have observed that if the vines grow too rank, there is little if any fruit on them. This condition is produced by a combination of factors, which, as far as Utah is concerned, involves chiefly an abundance of plant-food and plenty of water to utilize the fertility. As a consequence, on very productive soils there is danger of the plants "going to vine", unless controlled by the amount of water applied. The proper amount can be determined only by experience with the particular soil in question.

There are two other stages in the life of the tomato plant that must be watched with especial care. One is during the opening of the first blossoms. Over-irrigation at this stage may cause the plants to drop the flowers without setting fruit and thus become at least partially unfruitful.

It is advisable to use greater care in irrigation between the time of transplanting and fruit-setting than at any other period. Too much water may result in unnecessary vine growth and cause the blossoms to drop; too little water will dwarf the plants and decrease the crop. The second stage where caution is necessary is at harvest time. This period requires less moisture than at any other time. After the crop starts to ripen, it is desirable that its entire effort be expended in maturing and ripening the fruit already set. Over-irrigation at this time may also make the fruit softer and more watery and thus lower the quality. It is rather a common practice with a large number of growers to apply an excessive irrigation after the crop has fully set, at about the beginning of the ripening period, and then to irrigate very cautiously afterwards. For some reason this excessive irrigation checks the growth of the plant and hastens ripening. Over-irrigation, heavy rains, or storms of several days' duration during harvest time are disastrous. They tend to soften the fruit, to cause skin cracks which offer opportunity for decay organisms, and to produce a light-colored fruit, which is very undesirable to the canner. Shippers complain that tomatoes picked during or immediately after a rain will not carry in transit.

HARVESTING

The purpose for which the crop is grown determines the harvest practices. The canner desires his tomatoes red-ripe.

This requirement demands rather careful attention to picking. The amount of tomatoes a canner is able to use depends upon what he can sell, and this in turn depends to a large extent upon the quality. No matter what happens to tomatoes after they leave the growers' hands and before the can is sealed, it is certain that the canner cannot pack a better quality than he gets from the grower. This fact places an obligation upon the grower to avoid picking under-ripe, over-ripe, or damaged fruits. The acreage of tomatoes a grower is able to harvest ought to determine the amount he plants, since it is possible with a given labor supply to raise a great many more tomatoes than that same labor is able to harvest. This is the busiest time in the production of the crop, and, therefore, careless practices frequently creep in.

If the crop is grown for green shipment, picking is still a more highly specialized operation, since the crop must be picked when it has reached green maturity but before it has started to turn color. At this stage the seeds have reached practically their full size, and the substance filling the seed-cavity has changed to a jelly-like consistency. To recognize this stage without cutting the tomato requires experience and considerable skill. If the fruit is picked before this stage is reached it shrivels up and fails to ripen, and since most of the tomatoes must be shipped to considerable distances without becoming too ripe for use, it is important that they are not allowed to ripen much beyond this stage.

MARKETING

The item of marketing has been purposely omitted since in Utah the bulk of tomatoes is grown under contract with canners or shippers, and about the only choice the grower has in the matter is to decide whether or not he can afford to grow the crop under the terms of the best contract possible. In recent years attempts of the growers and packers to cooperate in arriving at the terms of the contract have been successful in some cases and not in others. It stands to reason that the success of an enterprise based upon factors as divergent as agriculture and manufacturing is dependent upon a thoroly mutual and sympathetic understanding between the two groups. The sooner this condition is brought about, the sooner will the grower and the packer be able to labor harmoniously together for the future development of the industry.

VARIETIES

Variety plays an important part in the success of the industry. The specific character of a suitable variety will differ to a certain degree, as to whether the crop is being grown for the cannery, for the local market, or for green shipment. From the standpoint of the canning industry three things are essential: (1) The variety must have good canning quality; (2) it must be early enough to avoid loss thru average fall freezes; and (3) it must yield sufficiently well to make the enterprise profitable to the grower.

Quality in Tomatoes.—Good canning quality involves a number of factors, chief among which are firmness, smoothness, and a dark red color, all of which affect either the quality in the can or economy in the manufacturing process. Good quality among other things demands that the fruit hold together during the preparation and cooking operations and that when the product reaches the consumer's table it have the well-known dark red tomato color. Smoothness and firmness have also an economic value. The packing season is an extremely busy one for growers and canners alike, and necessarily the tomato must be able to withstand a certain amount of rough usage. Rapid ripening urges the grower to maximum effort in order to harvest the crop before it becomes too ripe, and in turn frequently crowds the packing plant. As a result, the picker is less careful, and the canner is so rushed that he is often compelled to let tomatoes stand on his platform for some time before putting them in the can. A variety lacking in firmness will not suit such conditions.

Smoothness is also of economic importance. At the last analysis, the amount of the raw product actually sealed in the can determines the amount of the profit to the packer, and in turn to the grower. Waste anywhere in the industry decreases profit. Rough, ill-shapen tomatoes which are hard to peel and which must be trimmed excessively constitute one of the big sources of waste, and other things being equal are sufficient to condemn a variety or strain as undesirable for canning. Strains of tomatoes which crack easily, have large blossom-end scars, are wrinkled, or develop many ill-shapen fruits should be avoided.

Earliness.—There is a rather wide variation between the several varieties in the length of time required to mature the crop. Attention has already been drawn to the fact that the length of season may be modified to a certain degree by soil

type, by earliness of planting, and by cultivation and irrigation practices; but after every cultural possibility has been exhausted, there still remains a varietal difference which can never be entirely overcome. Since the relatively short growing season and the uncertainty of fall frosts constitute the most serious handicap for growing tomatoes in Utah, it becomes highly important to choose a variety, which, with the aid of the best field practices, can be depended upon to mature the major portion of its crop before the average fall frost date.

TABLE NO. 2.—Average spring and autumn frost dates for 12 places in Utah

	No. Years Records	Average date of killing frost		Latest date of killing frost in spring	Earliest date of killing frost in fall
		Last in spring	First in fall		
Brigham City			Sept. 22		
Corinne	21	May 18	Sept. 30	June 23	Aug. 22
Elberta	16	May 18	Sept. 30	June 16	Sept. 10
Farmington	17	May 7	Oct. 1	June 3	Sept. 8
Lehi	9	May 16	Sept. 19	June 13	Sept. 11
Logan	23	May 14	Oct. 8	June 17	Sept. 13
Midvale	9	May 22	Sept. 21	June 13	Sept. 10
Ogden	16	May 1	Oct. 7	June 16	Sept. 10
Provo	20	May 24	Sept. 24	June 17	Sept. 9
Salt Lake City	47	April 20	Oct. 19	June 18	Sept. 22
Spanish Fork	9	May 5	Oct. 8	June 1	Sept. 5
Tooele	23	May 13	Oct. 12	June 15	Sept. 14

Frost dates for tomato sections adjacent to Ogden (Utah) and Salt Lake City will be a few days later in spring and a few days earlier in fall. Neither will data for stations where records which have been kept for a short period be as reliable as from stations of longer periods.

Considerable deviation from the above figures may be expected in case of places at some distance from the stations listed. However, the older inhabitants will have a fairly good idea of how much difference to expect. There are frequently variations of a few days even within relatively small areas because of elevation, location with reference to canyons, and exposure. As a general rule, lower areas freeze first, while higher places or even lower districts with good air drainage may be frost-free for several days longer. Locations which come under the influence of canyon breezes are frequently favored spots for tomato-growing since the winds tend to delay the fall frosts. All of the factors mentioned above, together with that of soil type, have a bearing upon the choice of a variety.

While earliness is one of the important considerations in

this state, the fact must not be overlooked that yield, canning, and shipping quality are of greater importance. For this reason, the earliest maturing varieties, such as the Earliana group, Chalks Early Jewel, Bonny Best, John Baer, and some others, are not suited to Utah conditions except for early local markets or home-garden varieties because they lack either canning quality or productiveness, and in the case of the Earlianas both of these requisites. While the canning industry is awake to new possibilities, it has settled pretty well upon a relatively few varieties. Since the shipping phase of the industry is practically in its infancy, little is really known about suitable shipping varieties in Utah. Some varieties new to this state have been tried and have met with only mediocre success, and the enterprise has depended quite largely upon varieties already being grown for the canner. In fact, there will probably never be a very wide departure from standard canning varieties of the best type since these conform in matters of color, firmness, and smoothness to the requirements of the shipping trade.

Popular Varieties.—To date the varieties briefly discussed below have met with the best success for canning purposes:

Stone.—This variety meets the requirements for canning quality more nearly than any other. It is dark red in color, is firm to very firm, and the better strains are smooth. In years of comparatively long growing season, it will yield as well and under very favorable conditions will outyield other varieties. However, it has the disadvantage of requiring a rather long season to mature its crop and so is avoided by a great many growers.

Norton.—With the advent of Fusarium wilt into Utah, the Norton variety, which is a wilt-resistant selection from Stone, promises to become an important sort. It is an especially good shipping and canning tomato, but from observations to date is not quite as early nor productive as some other varieties. However, this may be overcome by proper selection.

Greater Baltimore.—This is probably the most popularly grown variety not only in Utah but thruout most tomato-canning sections of the nation. It is preferred to Stone by most growers because it commences to ripen a few days earlier, and consequently larger yields are obtainable on average years. As an average, the variety is not so well colored as Stone and is usually somewhat softer. However, the better strains of Baltimore are to be preferred in these matters to the poor strains of Stone.

Landreth.—The Landreth variety has increased in popularity of recent years, especially with the Japanese grower. While it may be a few days earlier than Baltimore, this is not its chief recommendation. It has the added advantage of maturing the bulk of its crop in a shorter season, while both Stone and Baltimore tend to ripen their fruit over a longer season. Such a condition requires more pickings. As a result, larger yields are obtainable on short seasons and fewer pickings are necessary. But it is decidedly inferior to either Stone or Baltimore in such essential canning values as color and firmness. However, it is a relatively smooth tomato.

Other Varieties.—Such varieties as Ignatum, Red Head, Red Rock and some others have been grown with varied results. Some new varieties have also made their appearance, notably the "Potato-leaf," which is still in a hybrid condition, and the "Utah Valley". While both of these have performed well under certain conditions and have considerable promise, their adoption as a major variety is not yet warranted.

IMPROVING THE CROP

IMPROVEMENT NEEDED

Variations.—Any discussion of tomato varieties would not be complete unless attention were called to the fact that greater variations occur within the most important varieties, at least, than exist between the average types of the varieties. This might be illustrated effectively by observations from a variety test at the Davis County Experimental Farm. In 1923 more than twenty strains of Stone tomatoes were grown from seed obtained from as many different sources. In the first place, there were great differences in such vine characters as size, habit of growth, and vigor. At harvest time the fruits varied in shape from flat to globe, in texture from soft to very firm, in earliness from early to very late, and in other characteristics in like proportion. In addition, some strains were very uniform while others contained a mixture of types. Fewer strains of Baltimore were grown, but a like condition prevailed. Such a state of affairs emphasizes the fact that great care should be taken to obtain seed from the most reliable sources. Fortunately, the canners have secured seed stocks for the majority of the growers and as a rule have given very careful attention to the matter. In most cases they have secured commendable strains, but occasionally in spite of every precaution, badly mixed or undesirable types have come in. The only

remedy for such a condition is for the growers to select their own seed either as individuals or as groups. However, the improvement and selection of seed stocks involves serious dangers and must be carried on carefully and skillfully. In the following paragraphs certain important steps are briefly discussed.

CONSIDERATION OF IMPORTANT CHARACTERS

The source of seed is not so important as the quality of seed. Home-grown seed may be worse than commercial stocks unless extraordinary precautions be taken in its selection. There are two things to be considered: (1) the plant and (2) the fruit.

The Plant.—In the first place, the entire plant is to be considered as a unit. A few very fine fruits from a plant lacking in thrift are not so desirable as a large number of fruits not quite so good from a vigorous, healthy vine. Even then there is no definite assurance that the plant will transmit its productivity to its progeny. Its superiority may be due on any given year to particularly favorable conditions. That is, a mediocre plant under very good circumstances may outyield a plant with much better hereditary qualities grown under less favorable surroundings. The only way to determine the real value of a plant is to keep its seed separate from other selections and judge by the results of the following years. Vine characters to be considered are vigor, habit of growth, and ability to set and mature a heavy crop.

The Fruit.—The fruit characters to be considered in making selections are color, smoothness, firmness, and size. A thick skin is also a matter of importance, since fruit with thin skins cracks more easily than that with thick skins. Of these, color, smoothness, and size may be determined by external observations, while the elements of firmness require some investigating of the internal structure of the fruit. Usually a tomato with small seed cavities having thick walls between them and thick outer walls in addition to being more meaty is firmer than one with large seed cavities and thin walls. This can be determined only by cutting the tomato open.

There are two general kinds of selection known as mass and pedigree selection. Mass selection consists of gathering the fruits from a few of the best plants in the field and mixing them together. It has considerable merit in the improvement of varieties. However, this method requires a longer time to

build up a superior strain. The pedigree system consists of carefully selecting a few outstanding plants and harvesting their fruits separately. As has already been stated, some or probably all of these may prove to be only average individuals when grown the following year and should be discarded, while a few may prove to be valuable selections. Patience and persistence are necessary in this work, but in the end the results are worth the effort.

METHODS OF SELECTING SEED

The following steps in selecting tomato seed are important:

Staking.—Sometime previous to the first picking, a careful examination should be made of the entire field and the outstanding plants staked. This selection should be made on the basis of plant vigor, freedom from disease, and amount of fruit set per plant. It is advisable to stake more plants than may be desired for seed since some of the first selections will undoubtedly be eliminated during the season. Some authorities advise two or three selections before harvest: one when the first fruits are set, one when the second fruits are set, and the other just before harvesting begins.

While the earlier selections will no doubt give the grower a little more information relative to the behavior of his plants, a thoro examination before the first picking will serve practical purposes very well. It will give a fairly good idea of earliness, amount of set, and to some extent size and shape. Care should be taken to prevent the harvesting of any fruit from the staked plants.

Mid-season Examinations.—During the harvest season each staked plant should be watched carefully to determine whether the plant performs consistently thruout the season. Sometimes the first fruits will be large and desirable in every respect, while the later fruit becomes small or ill-shapen. In other cases, the first fruit will have good color while partially protected by the vines, but after the vines have been disturbed and the fruits exposed to the sun, it develops that they are unusually susceptible to sun-burn. The same condition may be true in case of firmness. The stakes should be removed from such vines. If the plant develops even a sign of disease or unthriftness, the stake ought to be removed and the salable fruits harvested for market.

Harvesting the Seed.—The fruit of all plants that survive the rigid elimination tests recommended above should remain on the vines as long as possible without decaying. If a mass

selection only is desired, the fruits from all vines are picked together and pulped in a barrel and allowed to ferment. If the more preferable pedigree system is used, however, a number of quart fruit jars with screw tops should be provided. Each fruit should be cut as it is picked and examined as to internal structure and thickness of skin. The fruit should then be placed at one side. If after all fruits are examined, the vine proves to be one worth saving, the seeds and pulp should be squeezed into the fruit jar (care being exercised to keep skins out); it should then be set aside to ferment. This should be repeated for each vine remaining staked, being careful to keep the seed from each plant separate. Since *Fusarium* wilt may be transmitted in the seed, extreme caution should be exercised to avoid selecting seed from diseased plants. A plant may have a mild infection of wilt, which cannot be detected by external observation. A safe practice would be to pull the vine after the fruit is picked. The roots and lower stems should be cut open and examined for discoloration. If any is found, the seed should be discarded.

Cleaning the Seed.—If the skins are kept out of the barrel or the jar, the seed-cleaning process will be a much easier one. If temperature is right, the fermentation process may be advanced far enough in 24 to 48 hours, at which time water should be added and the entire mass agitated. The seeds will settle to the bottom, and most of the pulp may be poured off. Some pulp will remain after the first treatment, and the process may need to be repeated two or three times. If seeds are allowed to remain in the liquor too long, some will start to grow and the germination of others may be injured; hence, it is best to clean and dry them as soon as they have fermented long enough to loosen the seeds from the pulp. The process of drying should be rapid for the same reason. If spread out in thin layers where there is good air circulation there need be no danger of injury during drying.

TESTING THE SELECTION

One can never be sure of results until this process has been completed. When the seeds are cleaned in the fall, each lot should be given a number and carefully stored away. In the spring each lot should be planted separately in the hotbed and labelled. At transplanting time, each lot should be planted together, care being taken not to replace the dead plants unless some of the same lot are available. Filling in with any other plants will ruin the project. There need be no worry about crossing in the field. In most cases this is negligible. During

the harvest season, very accurate examinations should be made and a decision made as to which one of the lots is the best. When this decision has been made, further selection must not be made indiscriminately from the best group. While there is some question as to whether any further improvement is possible, it is a safe practice for the grower to make only a few selections each year and then only after a series of rigid examinations. Each plant may be kept separate as before, but usually more seed is required than can be obtained from a few plants. If the grower has the urge and the time to continue individual plant selection year after year, it is well. However, after an especially good strain has been obtained by pedigree selections, good practical results may be obtained by choosing just enough seed for his own use from the very best plants each year by mass selection. A bushel of tomatoes will yield from three to five ounces of seed, and a pound will be ample to plant from 15 to 20 acres, making allowance for accidents of various kinds.

CONTROLLING THE PESTS

DISEASES

Tomatoes have their quota of pests, both of insects and especially of fungous diseases. The most important diseases include *Fusarium* wilt, western yellow blight, and mosaic.

Fusarium.—*Fusarium* wilt is caused by a fungous organism which develops in the water-conducting tissues of the plant. It may be transmitted by the seed, and when once it gains entrance into the soil lives there for an indefinite period. Two methods of partial control are available: (1) long-time rotations and (2) the use of wilt-resistant varieties.

Western Yellow Blight.—The disease known variously as blight, yellow blight, and western yellow blight, proves to be extremely serious in some years. While there have been some blighted plants in almost every field every year, they have been of minor importance, with the exception of the years 1906, 1924 and 1926, when extremely serious epidemics of western yellow blight occurred. Very little is definitely known about the cause of this disease, nor even the methods by which it spreads. Very recently evidence has been obtained indicating possible relationship to curly-top of sugar-beets. It is, however, associated with certain climatic conditions. Western yellow blight may be expected to be serious during years of low humidity and excessive winds.

Mosaic.—Mosaic is characterized by a mottling of the leaves in the milder cases and a reduction of leaf area and even death in the aggravated forms. Practically nothing is known about the cause. It is known, however, that the disease does attack certain perennial weeds related to the tomato and overwinters upon them. Insects transmit mosaic from such host plants to the tomato. So far as is known, the wild ground cherry is the most important one in Utah, and consequently diligent efforts should be made to eradicate it.

INSECTS

The insect problem is not so serious in Utah as is the disease problem, altho cutworms, flea-beetles, and tomato worms cause some damage.

Cutworms.—Cutworms frequently reduce the stand of plants by chewing the seedlings off near the surface of the ground. They are most serious when tomatoes follow sod or alfalfa, and when fields are located close to uncut fence rows and ditch banks. Consequently, one means of control consists in keeping ditch banks and fence rows clean, so they cannot offer places of refuge for the worms. Cutworms may also be controlled by poison bait. "Mix thoroughly $\frac{1}{4}$ pound white arsenic with a peck of dry bran. Stir a pint of cheap syrup or molasses into 4 to 6 quarts of water. Use this to make up the poisoned bran into a mash. The addition of chopped lemons or oranges makes the bait more attractive. Amyl acetate may be substituted for the fruit. Let the mixture stand several hours." A small amount of this bait should be scattered around the plants during the late afternoon or evening. It may be necessary to make several applications.

Tomato Worms.—Tomato or potato worms feed upon the leaves of the tomato plants. Because of their voracious appetites they may cause serious damage to individual plants. However, they are seldom very numerous and may be controlled to best advantage by hand-picking. Early morning (about sunrise) is the best time to look for them since at this time they are feeding near the top and are easily seen. Lead arsenate sprays are sometimes used if the worms become very numerous (3 pounds of dry lead arsenate to 100 gallons of water).

Flea-beetles.—When flea-beetles become numerous they feed upon the leaves of young tomato plants. Weak plants are especially susceptible to injury. It is not always necessary to make use of control measures. In case it becomes necessary to

guard against them, the plants may be dipped in a solution of lead arsenate at time of transplanting (1 pound of dry lead arsenate to 30 gallons of water) or they may be sprayed after they are set in the field with the same strength of arsenate of lead spray or with a combination of lead arsenate and bordeaux mixture.

SUMMARY

The production of tomatoes for the cannery and for shipping is an important agricultural industry in Utah.

Good plants are essential to successful tomato-growing. They can be grown successfully at home, with good hotbed equipment and with careful attention to preparation of the bed and to its ventilation and irrigation.

Well-prepared sandy loam soils are best adapted to tomato-growing in Utah.

Irrigation must be very carefully performed during early blooming and during harvesting.

The quality of tomatoes depends upon firmness, smoothness, and color. The Stone variety is firm, smooth, and dark red. Greater Baltimore and Landreth are also popular varieties.

There is need for improvement of tomato varieties. It is possible for an interested grower to build up a better strain by proper selection.

(College Series No. 226)

LIST OF AVAILABLE PUBLICATIONS

BULLETINS

- 121—Soil of Southern Experiment Station.
- 124—Fruit Variety Tests on Southern Experiment Farm.
- 127—Report of Richmond-Lewiston Cow-Testing Association (1913).
- 128—Blooming Periods and Yields of Fruit in Relation to Minimum Temperatures.
- 131—Variety Tests of Field Crops in Utah (1914).
- 132—Minor Dry-land Crops at Nephi Experiment Farm.
- 133—Irrigation and Manuring Studies, Pt. 1.
- 134—Nitric Nitrogen Content of Country Rock.
- 137—Quality of Home-grown Wheat vs. Imported Wheat.
- 138—How to Control Grasshoppers.
- 139—Movement of Soluble Salts with Soil Moisture.
- 140—Summer Pruning of a Young Bearing Apple Orchard.
- 141—Variation in Minimum Temperatures due to Topography of a Mountain Valley in Relation to Fruit-growing.
- 143—Fruit Tree Root Systems.
- 144—Water Table Variations.
- 145—Soil Alkali Studies.
- 147—Alkali Content of Irrigation Waters.
- 150—Further Studies on Nitric Nitrogen Content of Country Rock.
- 151—Freezing of Fruit Buds.
- 152—Effect of Soil Moisture on Certain Factors in Wheat Production.
- 156—The Irrigation of Sugar-beets.
- 158—Soil Moisture Studies under Dry-farming.
- 159—Soil Moisture Studies under Irrigation.
- 160—Important Factors in Operation of Irrigated Farms.
- 161—Orchard Heating.
- 163—Composition of Irrigation Waters of Utah.
- 165—Labor Costs and Seasonal Distribution of Labor in Irrigated Crops.
- 166—Climate of Utah.
- 167—Irrigation of Oats.
- 168—Relative Resistance of Various Crops to Alkali.
- 169—Use of Alkali Water for Irrigation.
- 173—Duty of Water in Cache Valley, Utah.
- 178—Irrigation of Barley.
- 181—Duty-of-Water Investigations on Coal Creek, Utah.
- 183—Water-holding Capacity of Irrigated Soils.
- 184—Farm Management Study of Great Salt Lake Valley.
- 185—Influence of Nitrogen in Soil on Azofication (Technical).
- 186—Irrigation Experiments in Sugar-beets.
- 187—Irrigation Experiments in Potatoes.
- 188—Maintaining the Productivity of the Soil.
- 189—Ridding the Land of Wild Morning Glory.
- 190—Corn Silage in the Dairy Ration.
- 191—Oedipodinae of Utah (Technical).
- 192—Biennial Report of the Director, 1923-24.
- 193—Cache County Water Conservation District No. 1.
- 194—The Influence of Storage on the Composition of Flour (Technical).
- 195—Field Studies of Sugar-beet Nematode.
- 196—Fruit Tree Leaf Roller.
- 197—The Pear Leaf Blister Mite as an Apple Pest.
- 198—Report of Director (for 18-month Period from Jan. 1, 1925 to June 30, 1926).
- 199—Mutual Irrigation Companies in Utah (in press).
- 201—Economic Insects in Some Streams of Northern Utah (in press).

CIRCULARS

- 8—Varieties of Fruit Recommended for Utah.
- 12—Thinning Apples.
- 13—Fruit for Exhibition.
- 17—Number and Distribution Licensed Stallions and Jacks, 1913.
- 18—Better Horses for Utah.
- 19—Licensed Stallions in Utah, 1915.
- 21—Dry-farming in Utah.
- 22—Some Sources of Potassium.
- 23—Seed Situation in Utah (1916).
- 24—Licensed Stallions in Utah, 1916.
- 26—Storing Vegetables for Winter.
- 27—Licensed Stallions in Utah, 1917.
- 28—Contagious Abortion in Mares and Cows.
- 29—Control of Rodent Pests.
- 30—Codling Moth.
- 31—Alfalfa Weevil.
- 34—Sugar-beet Production in Utah.
- 35—Licensed Stallions in Utah, 1918.
- 39—A Day at the Utah Agr. Exp. Station (contains complete List of Publications from 1890-1918, inclusive).
- 41—Soil Alkali.
- 44—Agriculture of Utah.
- 48—Rural Credits in Utah.
- 49—This Public Domain of Ours.
- 51—Foot-and-Mouth Disease.
- 54—The More Important Insects Injurious to the Sugar-beet in Utah.
- 57—Economy in Harvesting Sugar-beets.
- 58—Potato Production in Utah (Revision of Circular 40 now out of print)
- 59—Control of Stinking Smut of Wheat with Copper Carbonate.
- 60—Seed-Potato Treatment.
- 61—Rules and Regulations for Third Utah Intermountain Egg-laying Contest.
- 62—Summary of Publications (from September 1925 to September 1926).
- 63—Tomato Culture in Utah.
- 64—Onion Growing in Utah.

Address:

Publications Division,
Utah Experiment Station,
Logan, Utah, U.S.A.